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13. ABSTRACT (Maximum 200 words) An invitational workshop was held in connection with the Spring 1990 MRS Meeting in San Francisco. This was the first meeting on this emerging subject. Approximately 55 attendees were present and participated in the discussions.					
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# FINAL REPORT

## LOW TEMPERATURE GAAS WORKSHOP

*SAN FRANCISCO, CA*

*APRIL 20, 1990*

This invitational workshop was the first meeting of any kind on this emerging subject. The workshop was held in conjunction with, but not as a part of, the Spring 1990 Materials Research Society Meeting. The attendance was deliberately kept small - approximately 55-60, to afford an informal, interactive atmosphere.

This succeeded quite well. The Session Chairs did an excellent job of organizing the four, quarter-day sessions into stimulating discussions. The interchanges continued through the coffee breaks and lunch.

Attached are several documents pertaining to the Workshop. The first is a copy of the Call for Papers sent to selected potential attendees. This explains something of the background of the subject matter and the intentions of the Workshop.

The next item is the Final Announcement for Attendees. This gives meeting details as well as a list of the workshop organizers. The sponsor was AFOSR exclusively.

The final document is the workshop follow-up letter containing an annotated list of attendees.

Note Added in Proof: This workshop played a major role in leading to the first public meeting on this subject -- a 2 1/2 day symposium held at the Fall 1991 MRS Meeting in Boston.



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Dear Colleague

In 1987 Robert Calawa and Frank Smith of MIT/Lincoln Labs reported on a remarkable new approach to growing MBE GaAs layers. These materials are often referred to as low temperature GaAs buffer layers. Here, low temperature indicates growth at substrate temperatures significantly below the usual range of 580-650 C.

A variety of potential applications soon became apparent. This includes the reduction in side- and backgating in analog and digital circuits and the fabrication of ultrafast photoconductive switches. Subsequent reports by the MIT team and others continue to address applications and to seek an understanding of the unusual material properties of the layers. Much remains to be done to reach these goals.

A small workshop is being organized to address the status and potential of this new technology. You are invited to participate in light of your research interests and activities.

The one-day workshop will take place during the Spring Meeting of the Materials Research Society. The MRS Meeting will be held April 16-20, 1990 in San Francisco. For your information, an announcement on the Spring MRS Meeting is enclosed. While the MRS is assisting in the organization of the workshop, the workshop is not officially affiliated with the MRS Meeting. Workshop participation is by invitation only.

There will be discussions on growth, characterization, modeling and applications. Among the issues to be addressed are: growth temperature and rate, growth initiation, layer thickness, annealing effects, other materials for low temperature buffers (ternaries, InP, etc.), MOMBE or MOCVD growth, identification of point and extended defects, compensation mechanism(s), electrical/optical/structural characterization, interfacial quality, hopping versus normal conductivity, transport modeling, buffer layer stability, noise measurements, radiation effects, and novel applications of all kinds.

The format to be followed will be similar to WOCSEMMAD - informal, brief contributions followed by extensive discussion. Most presentations will consist of 3-5 viewgraphs of results or concepts. It is expected that all attendees will actively and openly participate in the workshop. The total attendance will be held to 50 or less.

Please complete and return the enclosed form whether or not you are interested in attending. Those planning to attend will be sent further details on the specific date of the workshop (to be selected after MRS completes the scheduling of the Spring Meeting), registration procedures and technical details. There will be a modest workshop fee to cover meal and break expenses. The sponsor (AFOSR) plans to provide a partial travel subsidy to all participants.

If you have technical questions or suggestions, contact Gerald Witt or Eicke Weber.

WORKSHOP TECHNICAL COMMITTEE

Gerald L. Witt  
AFOSR/NE  
(202)767-4931

Eicke Weber  
UC (Berkeley)  
(415)486-5933

Robert Calawa  
MIT/Lincoln Lab  
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David Look  
Wright State University  
(513)255-1725

Umesh Mishra  
(919)737-2336

## WORKSHOP ON LOW TEMPERATURE GaAs BUFFER LAYERS

### FINAL ANNOUNCEMENT FOR ATTENDEES

This final mailing is being sent to you in light of your announced intention to participate in this Workshop. Please advise Gerald Witt if your plans have changed. For those who will attend, please note the important information given below.

The Workshop will be held on Friday, April 20 at the San Francisco Marriott, 777 Market St, (415)896-1600. This is the same week and site as the Spring MRS Meeting. A brochure on the MRS Meeting was included in the first Workshop mailing. To secure the MRS Meeting conference rate at the Marriott (\$113/single, \$125/double), you must reserve rooms before March 19.

There are many alternative hotels, including several with less expensive rates, within proximity to the Marriott. The Marriott itself is very near the Moscone Conference Center. For a roster of alternative hotels within walking distance of the Marriott, FAX (412)367-4373, or contact the MRS Headquarters. Note that the Workshop is completely independent of the MRS Meeting with regard to registration or participation.

The Workshop will be held in <sup>Sanct</sup>Marina E-F at the Marriott. Registration will take place from 07:30-08:30 at a table outside the meeting room. There will be a registration fee of \$25, payable to the MRS at that time, to cover the meal and break expenses.

A continental breakfast will be served from 07:30-08:30 in the meeting room. A buffet luncheon will be served from 12:30-01:30 in a room to be announced at the Workshop. There will be AM and PM refreshment services, but no formal pause in the discussions.

The morning portion, from 08:30-12:30, will have two sessions. The first will address growth issues and will be chaired by Frank Smith. The second morning session will be concerned with characterization with Eicke Weber as chair. The two afternoon sessions will cover modeling and applications, with David Look and Umesh Mishra chairing. It is anticipated that the Workshop will conclude at approximately 5 PM.

The Workshop format will feature short presentations (5 minutes, 2-5 viewgraphs of results or viewpoints), and extensive group discussion. It is expected that all attendees will participate freely and openly in the discussions. The Session Chairs have responsibility for shaping and directing the presentations and exchanges. You may want to make prior contact with the appropriate Session Chair(s) prior to the Workshop to insure the scheduling of your talk.

The Workshop Committee look forward to seeing you at this exciting Workshop.

Gerald Witt	(202)767-4931	FAX (202)767-0466
Frank Smith	(617)981-4485	FAX (617)981-3433
David Look	(513)255-1725	FAX (513)258-5803
Umesh Mishra	(919)737-2336	FAX (919)737-3027

Eicke Weber is on leave in Japan. Contact Gerald Witt or see Eicke at the meeting.



DEPARTMENT OF THE AIR FORCE  
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFSC)  
BOLLING AIR FORCE BASE, DC 20332-6448

10 MAY 1990

To Participants in Low Temperature GaAs Workshop:

I trust that you found the workshop to be as interesting and informative as did I. Certainly, this novel material offers a number of intriguing materials science questions. To some degree, these questions were answered in the workshop; others remain to be further explored. At the same time, the variety of important potential applications provides another source of interest in the subject.

I have prepared and enclosed for your information and use a list of participants (plus a few names of those who could not attend) and a brief reference to the topic on which they spoke. I hope that this facilitates and encourages collaborations. In particular, a round-robin exchange of appropriate samples for thorough characterization would appear to be in order. If I can be of assistance in establishing any such collaborations, please let me know.

MRS has indicated to me their interest in organizing a regular symposium on this subject at one of the 1991 conferences -- probably at the Fall Meeting. I have agreed to assist in this task. Please keep me informed of your activities and results if you are interested in a presentation at that time.

We all owe special thanks to the organizers and session chairs -- Bob Calawa, Dave Look, Umesh Mishra, Frank Smith and Eicke Weber. And thanks to all of you for your contributions and comments.

Gerald L. Witt

LOW TEMPERATURE GaAs WORKSHOP ATTENDANCE LIST

April 20, 1990

James M. Ballingall  
Electronics Laboratory  
General Electric Company  
P.O. Box 4840  
Syracuse, NY 13221-4840  
(315)456-2675

Growth of LT GaAs;  
TEM of As precipitates

Robert Berg  
Department of Physics  
Wellesley College  
Wellesley, MA 02181

Raman Studies of LT Layers

A. R. Calawa  
MIT/Lincoln Laboratory  
Microelectronics Group  
Lexington, MA 02173  
(617)981-4576

He who showed us how

Kam T. Chan  
Hewlett-Packard Co.  
1412 Fountain Grove Pkwy  
Santa Rosa, CA 95403  
(707)577-3668

LT Buffers for MW Applications  
(Did not attend)

Ben Streetman  
University of Texas  
Department of Electrical Engineering  
Electrical Science Bldg 439  
Austin, TX 78712  
(512)471-5384

(His student attended)  
GaAs, AlGaAs Growth; MIS;  
resistivity, C-V; HEMT Buffer

Zhaoqiang Fang  
Wright State University  
Physics Department  
Col Glenn Hwy  
Dayton, OH 45435  
(513)873-2983

Hall; resistivity; photocurrent;  
PITS; TSC spectra

Julie E. Fouquet  
Hewlett-Packard Co.  
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PL of LT GaAs; InGaP

David E. Grider  
Honeywell SRC  
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Bloomington, MN 55420  
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Growth, use of LT InGaAs/InAlAs  
Buffers for HFETs  
(Did not attend)

Harold Grubin  
Scientific Research Associates  
P. O. Box 1058  
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Modeling of effects  
of deep traps on transport

Shantanu Gupta  
University of Michigan  
Ultrafast Science Lab  
1006 IST, 2200 Bonisteel Blvd  
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(313)763-1313

PC Switch from LT GaAs, AlGaAs;  
Time-resolved Photo-reflectivity

Maria Kaminska  
Institute of Experimental Physics  
Warsaw University  
Hoza 69  
00-681 Warsaw  
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011 48 22 287649

X-ray; EPR; photoquenching;  
annealing; conductivity mech.

Hilda Kanber  
Hughes Aircraft Company  
Torrance Research Center  
3100 West Lomita, MS 231/2019  
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LT GaAs layers for GaAs/Si;  
LT Buffers under MW devices

Yung-Chung Kao  
Texas Instruments CRL  
P.O. Box 655936, MS 147  
Dallas, TX 75265  
(214)995-4204

Pulse-doped FET device with  
LT GaAs Buffer

Christopher Kocot  
Hewlett-Packard Co.  
3500 Deer Creek Rd  
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Transient effects in digital ICs  
with LT GaAs Buffers

Robert M. Kolbas  
North Carolina State University  
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LT GaAs waveguiding structures;  
defect out-diffusion

Sheng S. Li  
231 Benton Hall  
Dept. of Electrical Engineering  
University of Florida  
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(904)392-4937

DLTS, I-V on MIM structures with  
LT GaAs; interface states; PC



Zuzanna Liliental-Weber  
Materials & Chemical Sciences Division  
Center for Advanced Materials  
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Atomic resolution TEM;  
convergent beam e-diffraction

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WRDC/ELR  
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David C. Look  
Wright State University  
University Research Center  
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resistivity; Hall;  
Hopping conductivity Model

M. Omar Manasreh  
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IR Absorption

George Maracas  
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LT GaAs via gas-source MBE;  
I-V; DLTS

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CBE growth of LT GaAs

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School of Electrical Engineering  
Purdue University  
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LT GaAs for HEMTs

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Hughes Research Laboratories  
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LT GaAs Buffers for GaAs/Si;  
LT InAlAs Buffers on InP

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LT GaAs for power devices

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PC switching with LT layers

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PC switching with LT layers

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DLTS, RBS; GaAs/Si

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William Schaff  
Cornell University  
School of Electrical Engineering  
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Si-doped LT GaAs layers;  
annealing; DLTS

Jasprit Singh  
Electrical Engineering  
University of Michigan  
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Growth modeling  
(Did not attend)

Frank W. Smith  
MIT/Lincoln Laboratory  
Microelectronics Group  
Lexington, MA 02173  
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Growth of LT layers; PL

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Bandgap defect states;  
Schottky barriers

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Code 6832  
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MEE growth; In doping;  
LT GaAs, AlGaAs; Zn doping

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LT Buffers for PM-HEMTs

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*510 486 4211 577 602*  
Eicke Weber  
Materials Science Department  
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*Planning 109*  
EPR; LT GaAs defects

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SUNY-Buffalo  
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X-Ray analysis; RBS; RTA

Gerald L. Witt  
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Organizer; sponsor

H. Yamamoto  
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Ohmic contacts to LT layers;  
Modeling

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RBS of LT material